



Welcome to the ELVHYS Dissemination Conference!

NTNU Office Brussels, Belgium

Federico Ustolin

16-17.09.2026



ELVHYS project No. 101101381 is supported by the Clean Hydrogen Partnership and its members. UK participants in Horizon Europe Project ELVHYS are supported by UKRI grant numbers 10063519 (University of Ulster) and 10070592 (Health and Safety Executive)

Dissemination Conference Agenda

Day 1, Wednesday 16 September 2026	
Time (CEST)	Presentation title (Speaker)
08:30-09:00	Registration
Opening and project overview	
09:00-09:10	Opening and welcome (F. Ustolin, NTNU; V. Molkov, UU)
09:10-09:40	Overview of ELVHYS project and main outcomes (F. Ustolin, NTNU)
09:40-09:50	Knowledge transfer to address key challenges in LH ₂ safety (D. Cirrone, UU)
09:50-10:20	LH ₂ transfer ecosystem, infrastructures and loading procedures (D. Houssin, AL)
10:20-10:50	<i>Coffee break</i>
Oxygen enrichment and performance of materials and LH₂ components	
10:50-11:10	Experimental study of oxygen enrichment during LH ₂ releases (J. Welch, HSE)
11:10-11:30	Resistance of materials to LH ₂ impinging jets and fires (E. Torres de Ritter, KIT)
11:30-11:50	Modelling LH ₂ jet fires and their interaction with insulation materials (G. Pio, UNIBO)
11:50-12:10	Fire tests of short LH ₂ transfer line elements (A. Friedrich, KIT)
12:10-12:30	Predictive tool to estimate the performance of LH ₂ components in a fire (F. Ustolin, NTNU)
12:30-13:30	<i>Lunch break</i>
LH₂ transfer technologies and operations: experiments and modelling	
13:30-13:50	Experiments on LH ₂ transfer facility performance for mobile applications (D. Lindner, DLR)
13:50-14:10	Testing the fuelling of LH ₂ tanks for heavy-duty vehicles (J. Knebel, KIT)
14:10-14:30	DISCHA tool to support LH ₂ transfer protocols development (A. Venetsanos, NCSRD)
14:30-14:50	Assessment of LH ₂ transfer influence on tank self-pressurization and venting (L. Claussner, NTNU)
14:50-15:10	<i>Coffee break</i>
15:10-15:30	sLH ₂ refuelling through entire equipment of HRS: concept, numerical modelling and simulation results (V. Molkov, UU)
15:30-15:50	Understanding the heat and mass transfer at HRS during an attempt to refuel the warm LH ₂ tank (V. Molkov, UU)
15:50-16:10	Self-pressurisation in a vacuum-insulated LH ₂ storage tank (M. Kamboj, UU)
16:10-16:30	Lessons learned from testing LH ₂ system and components (B. Broesicke, DLR, J. Knebel, KIT)
16:30-17:00	Q&A session and closure of the first day (F. Ustolin, NTNU; All)

Dissemination Conference Agenda

Day 2, Thursday 17 September 2026	
Time (CEST)	Presentation title (Speaker)
08:30-09:00	Registration
Assessment of LH₂ incident consequences in closed and open spaces	
09:00-09:20	Experimental study on the dispersion of LH ₂ from small scale leaks inside a tank connection space (W. Rattigan, HSE)
09:20-09:40	The pressure peaking phenomenon for cryogenic releases (D. Cirrone, UU)
09:40-10:00	Numerical modelling of LH ₂ leaks within tank/transfer connection spaces (L. Gray, HSE)
10:00-10:20	Numerical modelling of unignited LH ₂ tests (N. Koutsourakis, NCSR)
10:20-10:40	Accurate boundary conditions for LH ₂ storage tank modelling (A. Schiaroli, NTNU)
10:40-11:00	<i>Coffee break</i>
11:00-11:20	Modelling of consequences from loss of containment of LH ₂ equipment (I. Tolia, NCSR)
11:20-11:40	Research on BLEVE at KIT: experiments and simulations in a shock tube (E. Torres de Ritter, KIT)
11:40-12:00	Engineering tool to assess consequences of a BLEVE explosion (F. Ustolin, NTNU)
12:00-12:20	Throughout multiphase CFD model of BLEVE phenomena: from blast wave to fireball (D. Cirrone, UU)
12:20-13:20	<i>Lunch break</i>
Hazards and associated risk analysis for selected LH₂ transferring operations	
13:20-13:40	Identification and prioritisation of hazards for LH ₂ transfer operations (O. Aneziris, NCSR, A. Tugnoli, UNIBO)
13:40-14:00	Consequence analysis for selected LH ₂ transfer operations (A. Venetsanos, NCSR)
14:00-14:20	LH ₂ release and dispersion from 56 m ³ storage tank: hazard distances by flammability & frostbite (M. Shamsaddinsaeid, UU)
14:20-14:40	Analysis of incident occurrence frequencies (B. Linseisen, DLR)
14:40-15:00	Risk analysis for LH ₂ transfer operations (O. Aneziris, NCSR)
15:00-15:20	<i>Coffee break</i>
Training, strategies, guidelines and recommendations for LH₂ transfer technologies & RCS	
15:20-15:40	ELVHYS outcome to support education on safety of LH ₂ transfer technologies (D. Cirrone, UU)
15:40-16:00	Safety strategies, engineering solutions and guidelines for inherently safer design of LH ₂ transfer facilities (D. Houssin, AL)
16:00-16:20	Recommendations for Regulations, Codes and Standards (D. Houssin, AL)
16:20-16:50	Q&A session (F. Ustolin, NTNU; All)
16:50-17:00	Closing remarks (F. Ustolin, NTNU)



Overview of ELVHYS project and main outcomes

ELVHYS Dissemination Conference

Federico Ustolin

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Progress / Closed gaps

Fundamental/Modelling “Release”:

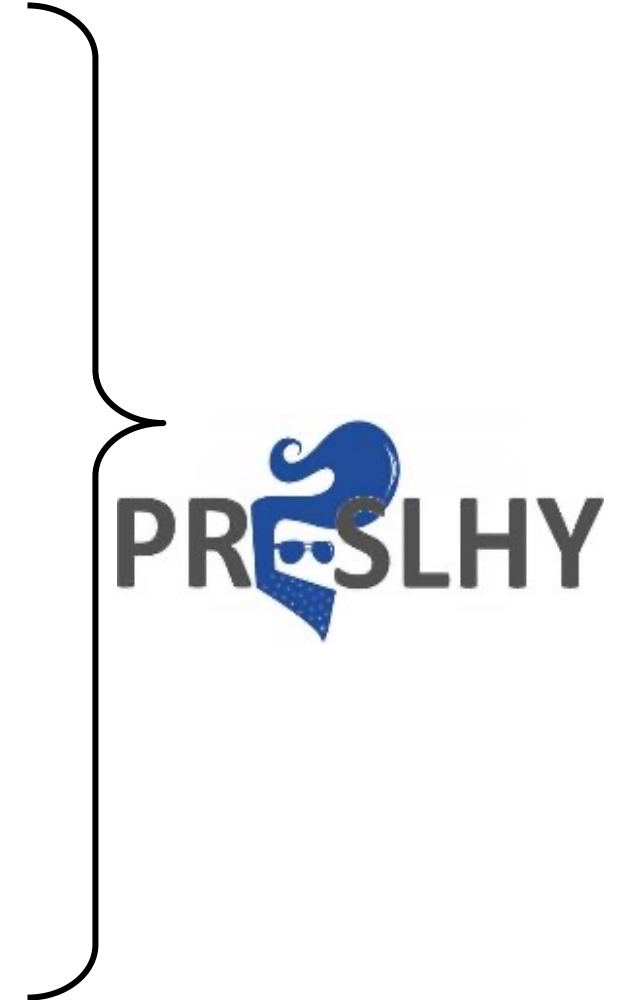
- ✓ Discharge coefficients for cryo- and cryocompressed releases
- ✓ Rainout phenomena better understood
- ✓ Fundamental data for mixing of large scale releases

Fundamental/Modelling “Ignition”:

- ✓ MIE and hot surface T determined for cryogenic conditions
- ✓ Empirical tests for RPT without fast reaction
- ✓ Electrostatics of cryogenic releases
- ✓ Worst case effects for small cryogenic inventories determined via variation of ignition time and position

Fundamental/Modelling “Combustion”:

- ✓ Flame length correlations validated
- ✓ σ , σ_{crit} and run-up distance for DDT determined at cryogenic conditions
- ✓ ...



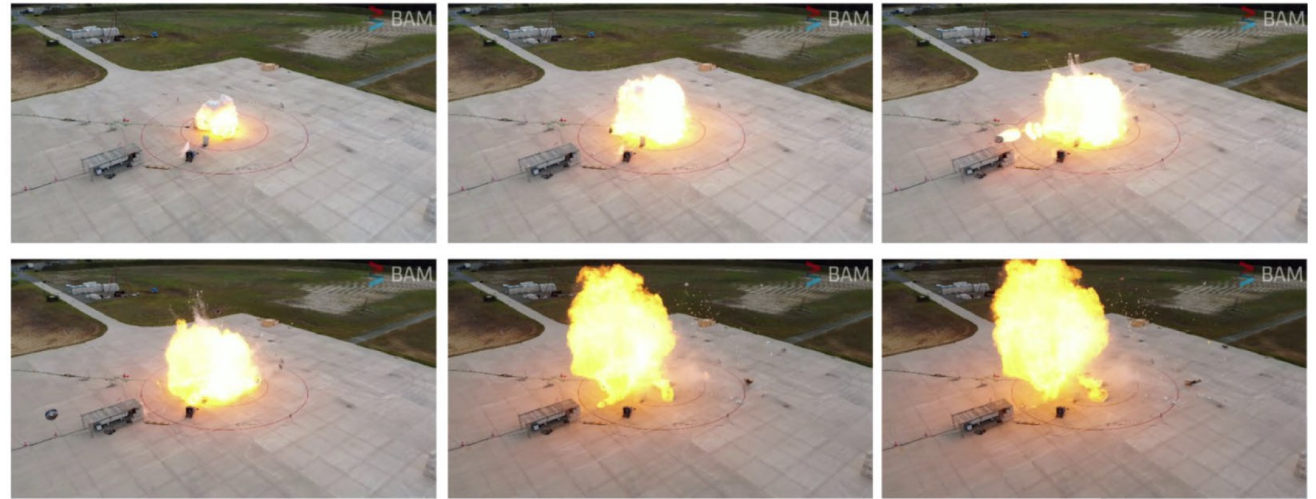
SH2IFT Project Findings



Fundamental/Modelling “BLEVE”:

- ✓ Experiments performed and BLEVE observed at BAM

(see van Wingerden, Kees, et al.
Chemical Engineering Transactions,
2022, 90. Jg., S. 547-552)



Fundamental/Modelling “RPT”:

- ✓ RPT observed in BAM tests spilling LH2 on water

(see van Wingerden, Kees, et al.
"Experimental Investigation into
the Consequences of Release
of Liquefied Hydrogen onto and under Water." (2022))

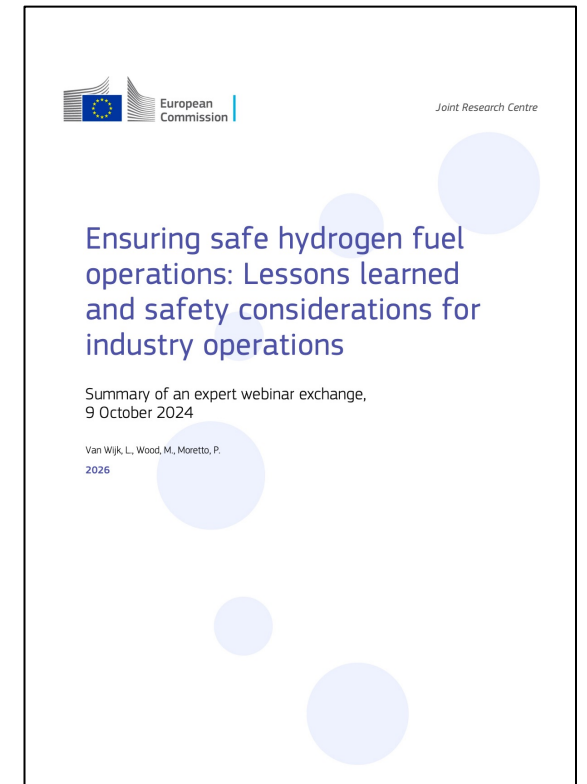


LH2 safety for operations in Europe

Liquid hydrogen (LH2) safety was highlighted in the recent **Joint Research Centre report** “Ensuring safe hydrogen fuel operations: Lessons learned and safety considerations for industry operations”.

LH2 safety in the section “Suggestions for safety enhancement”:

- Address gaps in emergency response protocols, large-scale electrolyser safety, and **liquid hydrogen handling** through targeted **research and standardisation**.



Source: <https://publications.jrc.ec.europa.eu/repository/handle/JRC144097>

ELVHYS



Enhancing safety of liquid and vaporised hydrogen transfer technologies in public areas for mobile applications

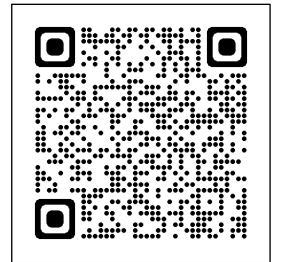
Funding: 2.0 M€

Duration: 2023-2026

Coordinator: NTNU



Partners:



Project
website

Objective: provide indications on inherently safer and efficient cryogenic hydrogen technologies and protocols in mobile applications by proposing innovative safety strategies including selection of effective safety barriers and hazard zoning strategies, which are the results of a detailed risk analysis.

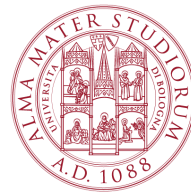
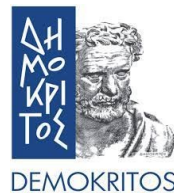
Website: <https://elvhys.eu/>



ELVHYS - Expected outcomes & objectives

1. Detailed **risk analysis** for LH2 transferring operations for mobile applications (ships, trucks, stationary tanks) fillings.
2. **Generic hazard distances** for LH2 transferring operations in the different applications, also addressing **Simultaneous Operations**.
3. **Guidelines for design** of LH2 transferring facilities.
4. **Consensual loading procedures** for LH2 transferring operations.
5. Provide inputs for developing **Standards, Technical Specifications, or Technical Reports** at the international level.

ELVHYS consortium



ELVHYS – Stakeholder Advisory Board

- **Number of SAB members:** 33 organizations
- **Countries of SAB organisations:**
 - **Europe:** Belgium, France, Germany, Italy, Norway, Sweden, The Netherlands, UK
 - **Outside Europe:** China, Japan, South Korea, USA
- **Type of organizations:**
 - Industries and companies: 10
 - Research centres: 5
 - Universities: 11
 - National public institutes: 3
 - Associations: 1 (HySafe)
 - Intergovernmental organisations: 1 (International Energy Agency)
 - Industry organisations: 1 (Hydrogen Council)
 - Rail operator: 1 (SNCF).

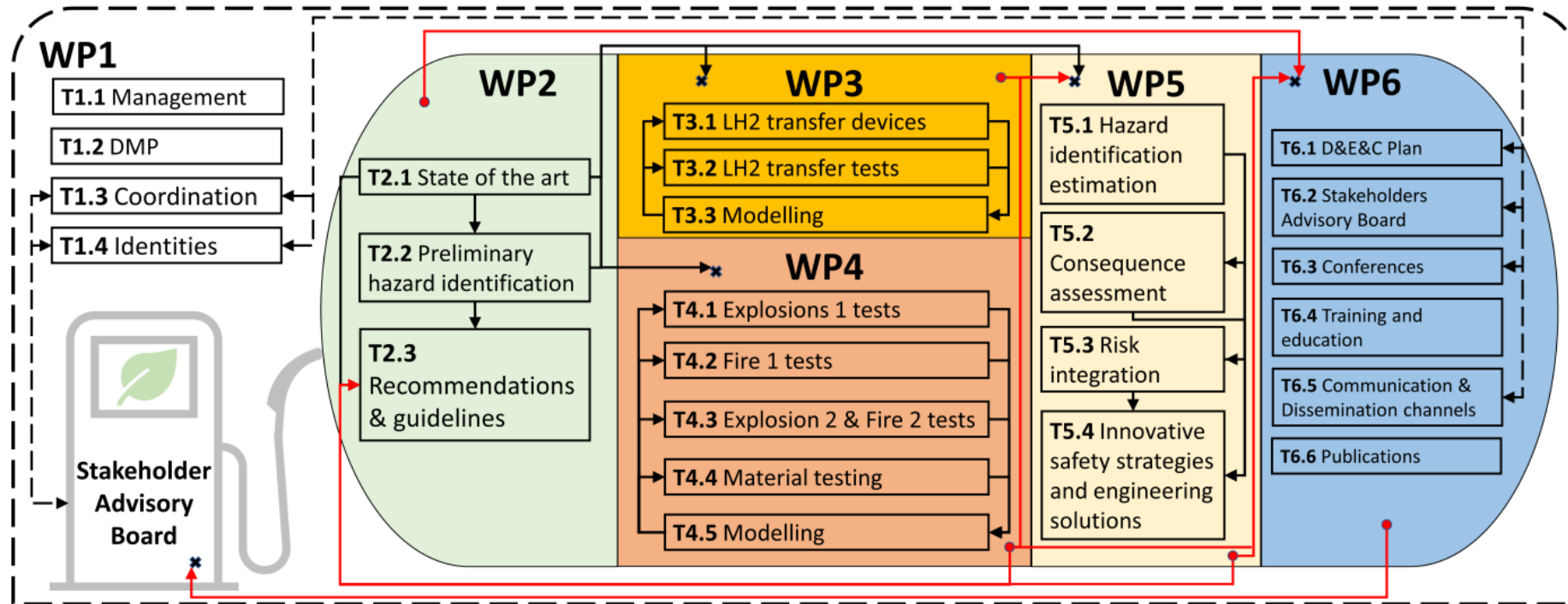
ELVHYS – Collaboration with other projects



Collaborations with other projects related to LH2 and cryogenic hydrogen transfer and storage were established:

1. **ALRIGH2T** (Horizon Europe, 2024-27 coordinator: ENEA, Italy)
2. **e-SHyIPS** (Horizon Europe, 2021-24 coordinator: Politecnico of Milano, Italy)
3. **EPSRC UK-MaRes Hub** (UK, 2023-27, Coordinator: Durham University, UK)
4. **ESKHYMO** (France, 2022-2026, coordinator: CEA, France)
5. **DelHyVEHR** (Horizon Europe, 2024-26, coordinator: Engie, France)
6. **HEAVEN** (Horizon Europe, 2023-26, coordinator: Rolls-Royce, Germany)
7. **LH2 Pioneer** (NFR, 2021-25, coordinator: SINTEF Energy)
8. **MF Hydra** (LH2 ferry, Norway, Norled)
9. **NICOLHy** (Horizon Europe, 2024-26, coordinator: BAM, Germany)
10. **sHYpS** (EU, coordinator (Horizon Europe, 2022-26, coordinator: NavalProgetti S.r.l., Italy)
11. **STACY** (EIG Concert Japan, 2022-2026, coordinator: Julich, Germany)

ELVHYS – Work Plan



- **WP1** (lead: NTNU) - Project Management & Coordination
- **WP2** (lead: AL) - From industrial background and strategy to findings application
- **WP3** (lead: DLR) - Cryogenic hydrogen transfer facilities performance
- **WP4** (lead: HSE) - Fires & explosions from cryogenic hydrogen transfer facilities
- **WP5** (lead: NCSRD) - Risk Analysis for selected cryogenic hydrogen transferring operations
- **WP6** (lead: UU) - Dissemination, exploitation, communication

ELVHYS – SoA on LH2 transfer and analysis



The main activities in WP2 during the project were:

- **Task 2.1** - LH2 transfer ecosystem, infrastructure description and regulatory challenges
 - **Sub-Task 2.1.1** LH2 transferring applications and associated feared events
 - **Sub-Task 2.1.2** Description of LH2 transfer equipment and protocols for LH2 transfer operations
 - **Sub-Task 2.1.3** Overview of existing RCS and identification of gaps
- **Task 2.2** - Preliminary major accident hazard identification for LH2 transfer operations
 - **Sub-Task 2.2.1** Overview of risk analysis methodologies
 - **Sub-Task 2.2.2** Preliminary major accident hazard identification and severity assessment
 - **Sub-Task 2.2.3** Research programme and expected results
- **Task 2.3** - Valorisation of the findings for safe LH2-based operation and use
 - **Sub-task 2.3.1** Guidelines for inherently safer design of LH2 transferring facilities
 - **Sub-task 2.3.2** RCS for cryogenic and LH2 transferring operations and facilities

ELVHYS – Experimental activities

Nr.	Phenomenon investigated	WP	Location	Partner
1	LH2 transfer operations from a giving to a receiving tank	3	Lampoldshausen (Germany)	DLR
2	Oxygen enrichment and condensed phase explosions	4	Buxton (UK)	HSE
3	LH2 Leakage into cold room/tank connection space considering barriers and obstacles	4	Buxton (UK)	HSE
4	Boiling Liquid Expanding Vapour Explosion (BLEVE) tests with a shock tube	4	Karlsruhe (Germany)	KIT
5	Fire tests of short LH2 transfer line elements	4	Karlsruhe (Germany)	KIT
6	Material testing against unignited and ignited LH2 jets	4	Karlsruhe (Germany)	KIT

ELVHYS – Experimental activities (1/6)

LH2 transfer operations from a giving to a receiving tank

- Experiment performed by **DLR** in collaboration with **KIT** in **WP3**.
- **Goal**: study the loading and unloading of DLR stationary tank (12 m³) and KIT transportable tank (0.4 m³).
- Different **initial conditions** were used during testing.
- Experiments were **completed** in 2026.
- Both **liquid nitrogen** and **liquid hydrogen** were used as medium.

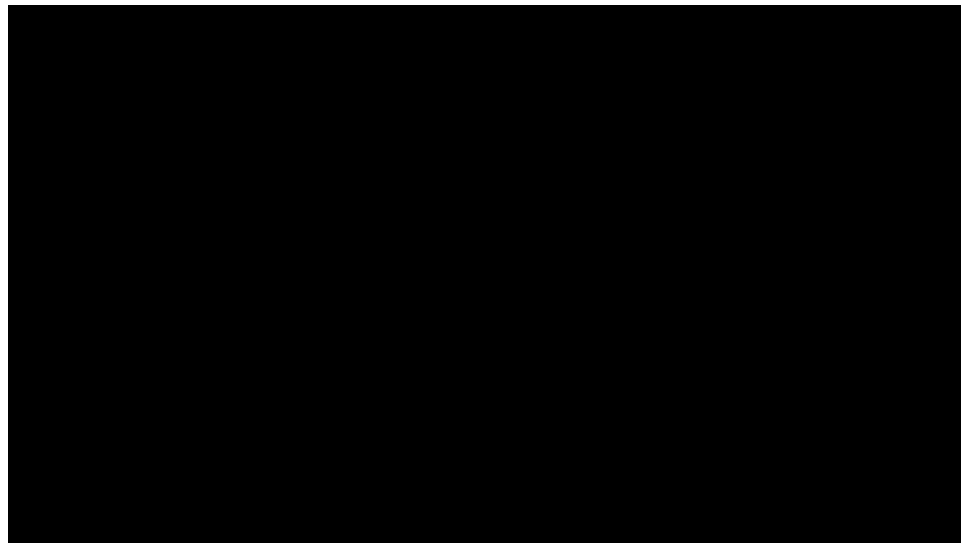


LH2 tanks used for the LH2 transfer tests (images courtesy of KIT)

ELVHYS – Experimental activities (2/6)

Oxygen enrichment and condensed phase explosions

- Experiment performed by **HSE** in **WP4** (Task 4.1).
- **Goal:** investigate phase change of air components when in contact with LH2.
- Experiments were **completed** in 2024.
- **Dataset** available on **Dataverse.no** database:
<https://doi.org/10.18710/YGHHTR>



Aerial view of HSE test pad during the tests (video courtesy of HSE)

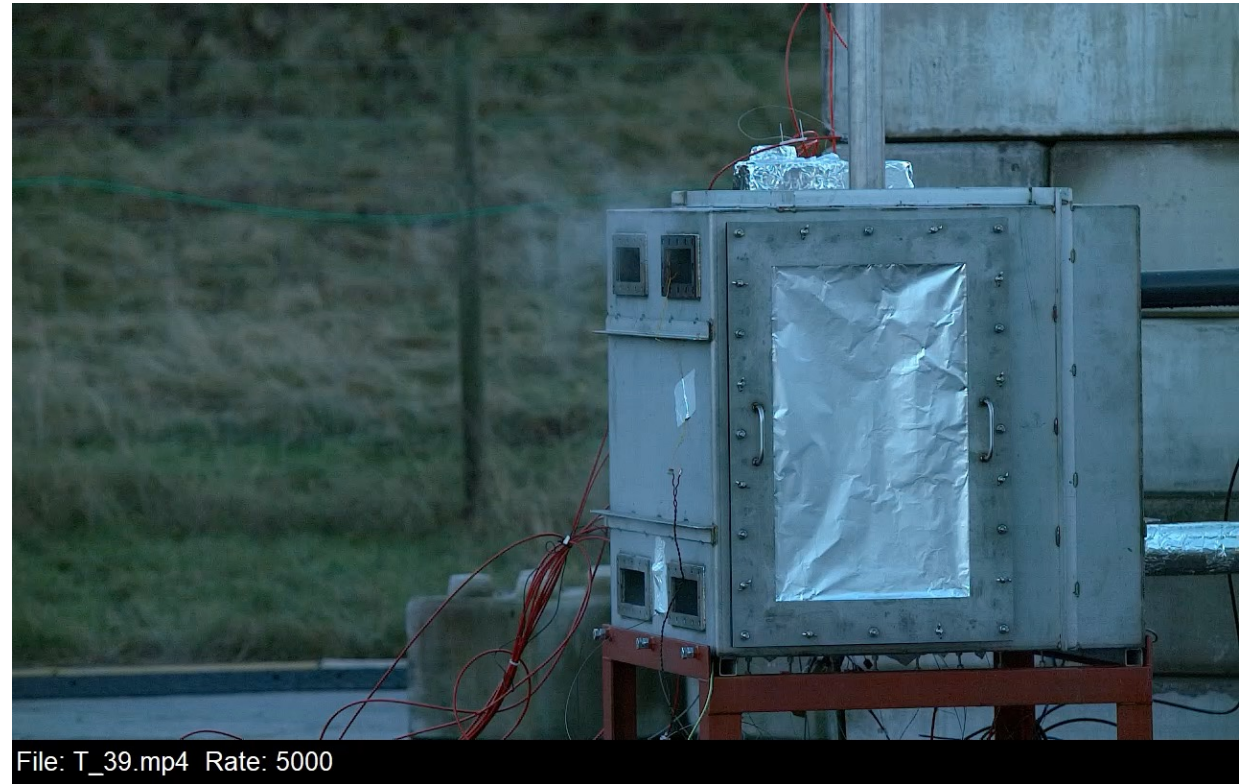


Task 4.1, rig and enclosure (image courtesy of HSE)

ELVHYS – Experimental activities (3/6)

LH2 Leakage into cold room/tank connection space (TCS) considering barriers and obstacles

- Experiment performed by **HSE** in **WP4** (Task 4.2).
- **Goal:** measure consequences of unignited and ignited LH2 releases in TCS.
- Experiments were **completed** in 2024.
- Dataset available on **Dataverse.no** database:
<https://doi.org/10.18710/JXJPOH>

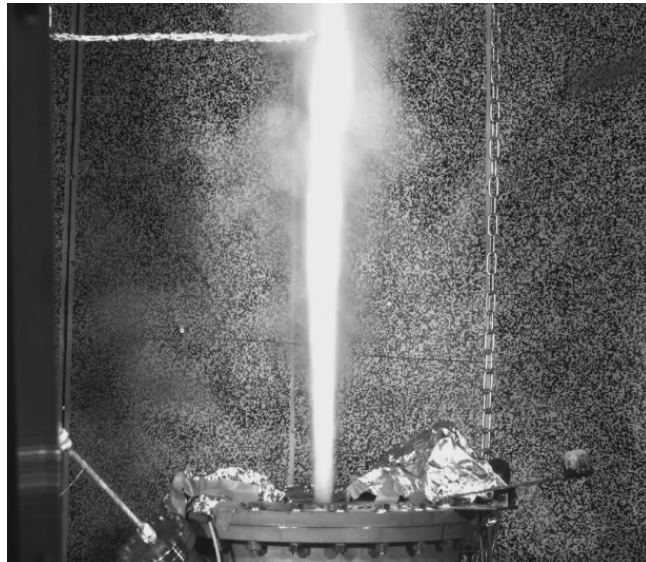


Test 39 - LH2 ignited release in cold box (video courtesy of HSE)

ELVHYS – Experimental activities (4/6)

BLEVE tests with a shock tube

- Experiment performed by **KIT** in **WP4** (Task 4.3.1).
- **Goal:** understanding the BLEVE explosion for LH2 and the contribution of the combustion process to the blast wave.
- Experiments were **completed** in 2026.



Cryogenic H₂ release from the shock tube during WP4 BLEVE tests at KIT (images courtesy of KIT)

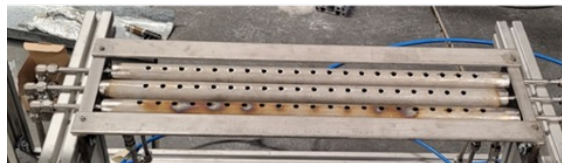
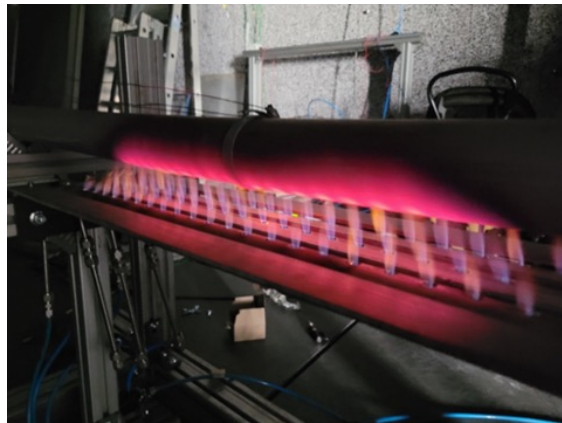


Shock tube setup installed in the safety vessel V220 at KIT (images courtesy of KIT)

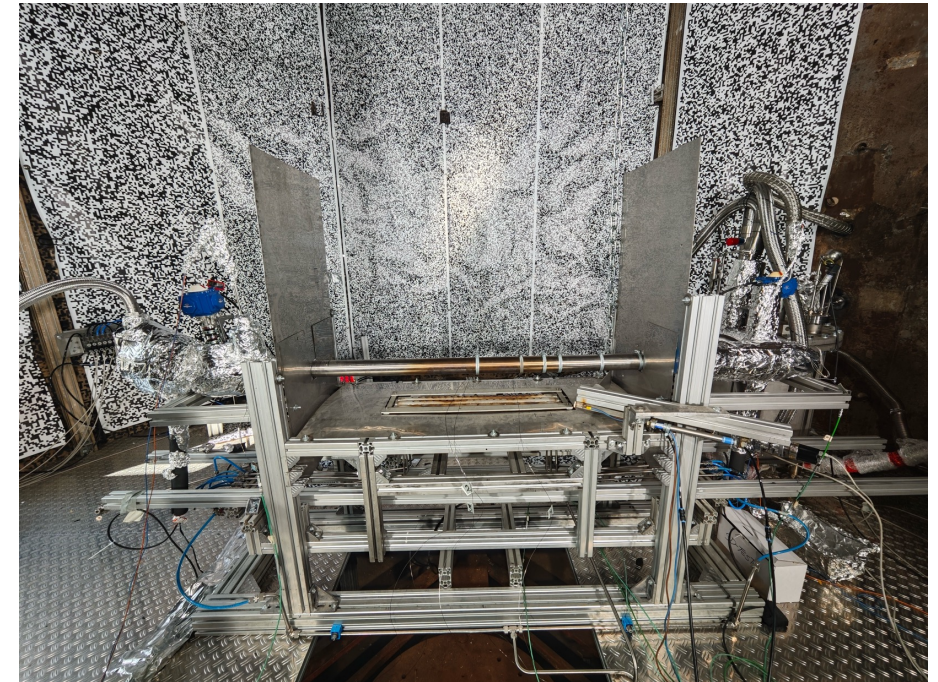
ELVHYS – Experimental activities (5/6)

Fire tests of short LH2 transfer line elements

- Experiments performed by **KIT** in **WP4** (Task 4.3.2).
- **Goal:** assess the performance of LH2 components exposed to external fire.
- Experiments were **completed** in 2026.



ELVHYS experimental setup (images courtesy of KIT)



Experimental bonfire setup installed in HYKA safety vessel V220 at KIT (images courtesy of KIT)

ELVHYS – Experimental activities (6/6)

Material testing against unignited and ignited LH2 jets

- Experiment performed by **KIT** in **WP4** (Task 4.4).
- **Goal:** study the behaviour of materials when impinged by unignited and ignited LH2 jets.
- Experiments were **completed** in 2026.



Ignited LH2 jets during WP4 material impingement tests at KIT



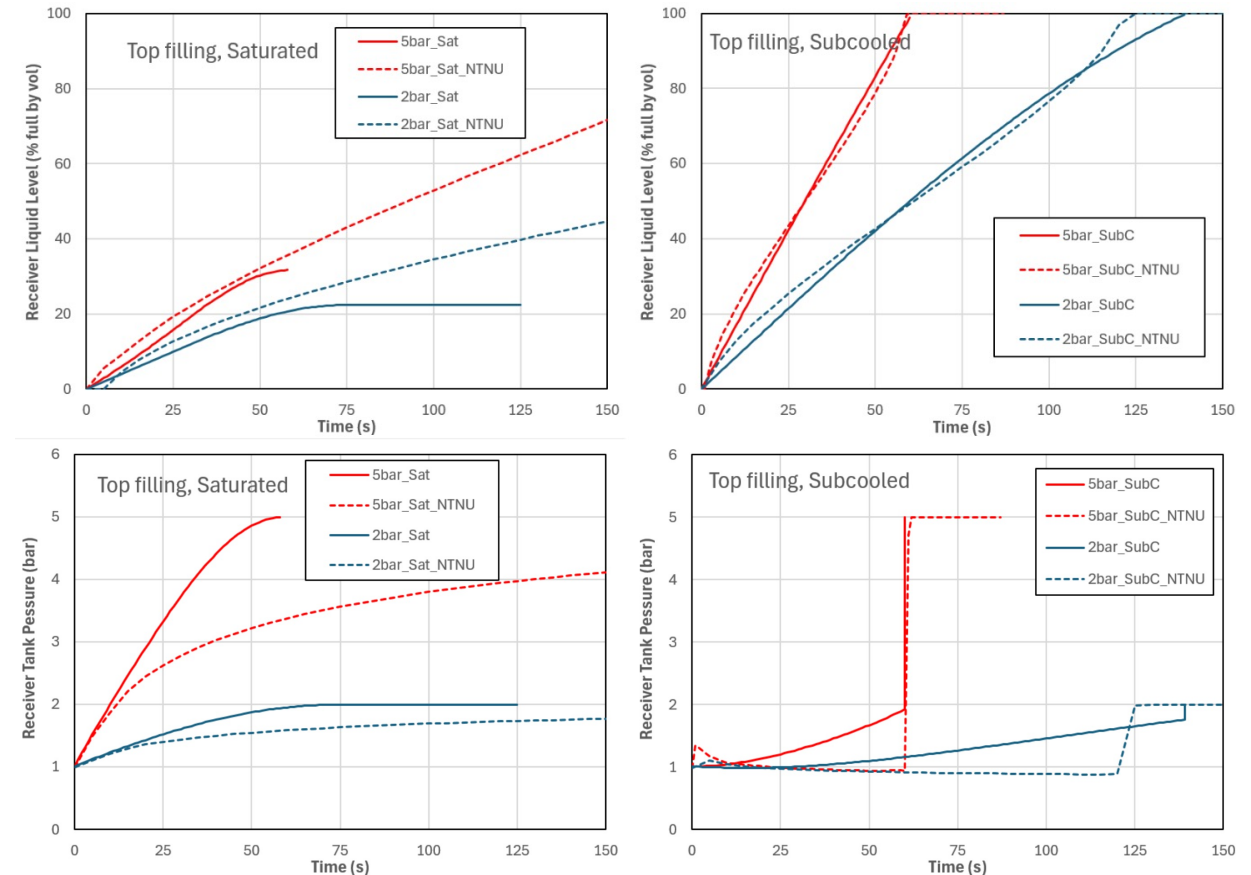
Free field test site of ITES-KIT with installed experimental rig for impingement (images courtesy of KIT)

ELVHYS – Modelling activities (1/3)

Cryogenic hydrogen transfer facilities performance (WP3)

Main modelling activities in WP3 were:

- **NCSR**D: Further development of **DISCHA** tool for LH2 transfer, validation, and application to ELVHYS experiments.
- **NTNU**: Development of **Aspen HYSYS** model for LH2 no-vent tank filling, and comparison with DISCHA.
- **KIT**: Modelling of **condensation blocking** in LH2 transferring process



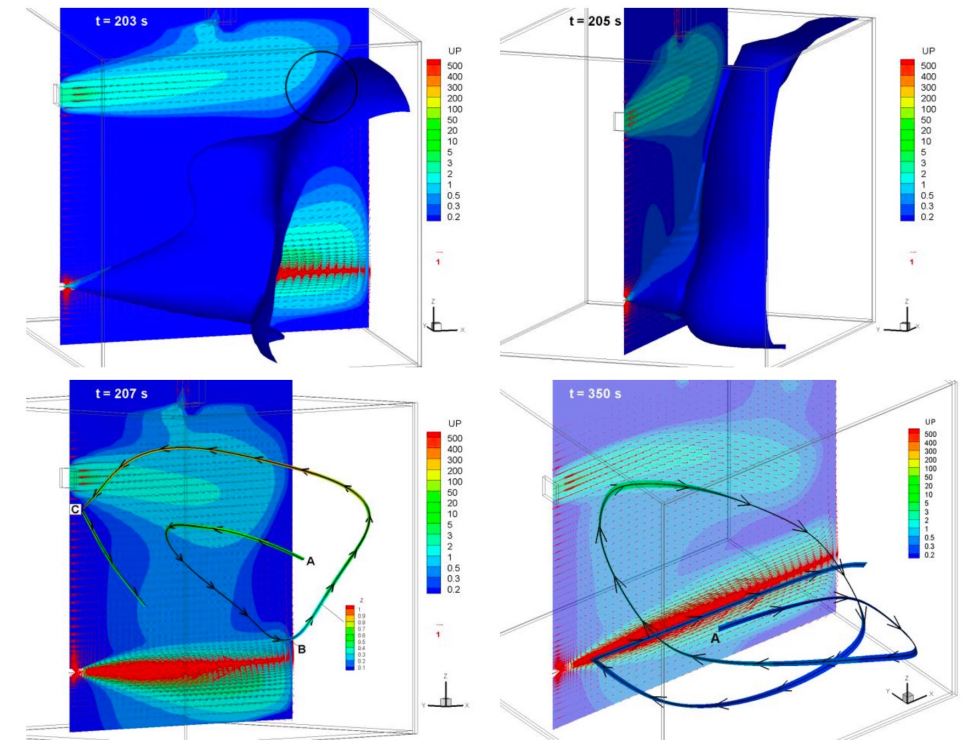
Comparison between DISCHA (NCSR) and NTNU models

ELVHYS – Modelling activities (2/3)

Fires and explosions from cryogenic hydrogen transfer facilities (WP4)

The main activities on modelling of fires and explosions were:

- **NCSRD:**
 - LH2 dispersion, combustion, and radiation phenomena.
 - LH2 BLEVE
 - H2 releases through a vent stack
- **UNIBO:** H2 jet fires
- **HSE:** LH2 leak into a TCS
- **NTNU:**
 - Time to failure of LH2 hoses exposed to fire
 - Shock tube experiments



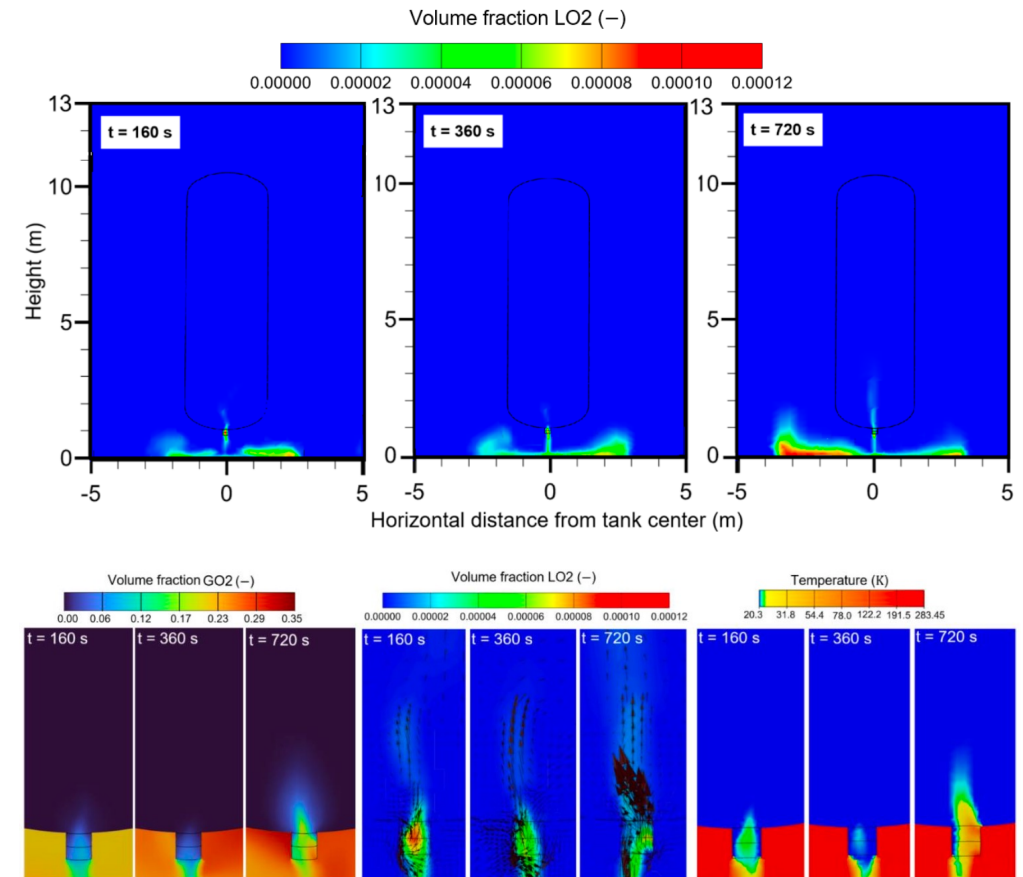
CFD simulations of cryogenic H2 releases through a vent stack performed by NCSRD

ELVHYS – Modelling activities (3/3)

Fires and explosions from cryogenic hydrogen transfer facilities (WP4)

The main activities on modelling of fires and explosions were:

- **UU:**
 - LH2 BLEVE blast wave and fireball
 - **Pressure peaking phenomenon**
 - “**Bubbling**” phenomenon; oxygen into LH2 tank
 - **Unignited** cryogenic H2 releases through a vacuum-insulated pipe
 - H2 releases through a **vent stack**



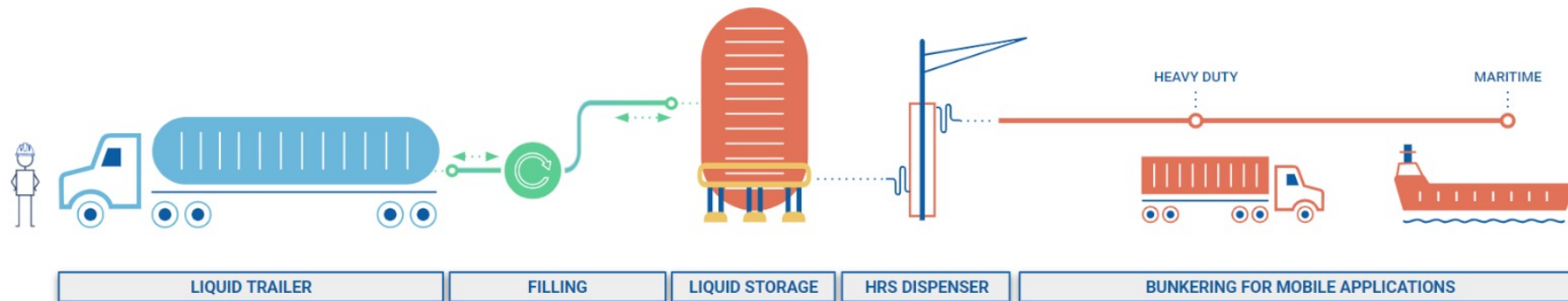
CFD simulations of the “bubbling” phenomenon performed by NCSR D

ELVHYS – Risk Analysis

Risk Analysis for selected cryogenic hydrogen transferring operations (WP5)

NCSRD partner is leading this activity supported by AL, DLR, KIT, NTNU, UNIBO, UU. The tasks of this risk analysis are:

- **Task 5.1** – Hazard identification and damage state estimation
- **Task 5.2** – Consequence assessment
- **Task 5.3** – Frequency assessment and risk integration
- **Task 5.4** – Innovative safety strategies and engineering solutions



(Image courtesy of Air Liquide)

ELVHYS – Workshop series (1/2)

Dissemination, communication, exploitation (WP6)

Six stakeholders' workshops and one seminar were organised by ELVHYS:

- **Workshop 1:** State-of-the-art of cryogenic transfer technologies and related safety issues (host: AL, 21.06.2023)
- **Workshop 2:** Experimental research and case studies of cryogenic hydrogen incidents (host: HSE, 29.11.2023)
- **Workshop 3:** Progress in modelling and development of fuelling/bunkering procedures (host: NCSRD, 07.06.2024)
- **International Stakeholders' Seminar** (host: UNIBO, 30.09-01.10.2024)



ELVHYS ISS held at UNIBO

ELVHYS – Workshop series (2/2)

Dissemination, communication, exploitation (WP6)

Six stakeholders' workshops and one seminar were organised by ELVHYS:

- **Workshop 4:** Understanding of heat and mass transfer for cryogenic and liquid hydrogen (host: NTNU, 04.12.2024)
- **Workshop 5:** Towards RCS for cryogenic and LH2 transferring operations and facilities (host: KIT, 05.06.2025)
- **Workshop 6:** Project outputs, remaining knowledge gaps and technological bottlenecks (host: UU, 05.12.2025)



4th ELVHYS stakeholders' workshop at KIT



Thank you for your attention

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UK Research
and Innovation

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